



Report to the Secretary of Defense

A Review of Spectrum Management

Report FY10-06

- **Recommendations on how to better use and manage Radio Frequency Spectrum.**

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE JAN 2010		2. REPORT TYPE		3. DATES COVERED 00-00-2010 to 00-00-2010	
4. TITLE AND SUBTITLE A Review of Spectrum Management				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Defense, Defense Business Board, 1400 Defense Pentagon, Washington, DC, 20301-1400				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 39	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Recommendations for Spectrum Management

TASK

Over the last several decades the Department of Defense (DoD) has increasingly relied upon the availability of radio frequency (RF) spectrum in order to conduct modern warfare. At the same time, there has been a dramatic increase in demand from the commercial sector for the use of the same frequencies and in the same geographies that are critical to the DoD. This is complicated even further as Administrations, including the current one, are making more RF spectrum available for auction in order to provide broadband and mobile capacity to the commercial sector for civilian use – and generate revenues to reduce the deficit. These efforts, combined with pending legislation that could mandate a full inventory of federal spectrum use (including classified use), are resulting in the need for DoD to increase the efficient utilization of the available spectrum in the near term and develop a sound forward-looking strategy for future use of spectrum. The Defense Business Board (DBB) was asked to review DoD's policies in this area and a copy of the official Terms of Reference (TOR) may be found in **Appendix A**.

Mr. Joe Wright co-chaired the Task Group, along with Defense Science Board (DSB) member, Mr. John Stenbit. The DSB was asked to support this task because of the strong technical component, but the overall task group was focused mainly on management issues. They were joined by DBB Member Mr. Atul Vashistha, and DBB Consultant Mr. Steven Price. The Task Group Executive Secretary was Col Kathleen Sakura, USAF, Military Assistant to the DBB.

PROCESS

In addition to relying on their own professional expertise in communications and information technology, the Task Group reviewed former studies by DSB, Air Force Scientific Advisory Board, Government Accountability Office (GAO) and the previous DoD Spectrum Strategy documents, including the 2002 Spectrum Management Strategic Plan (a capstone strategy document) for prior recommendations on use of spectrum. The Task Group also reviewed the Federal Spectrum Plan and

industry reports for projected demand. The Task Group interviewed current and former government leaders who have dealt with spectrum management including current and former federal communications commissioners, former ambassadors to the world radio conferences, and current leadership in Department of Commerce, and the National Telecommunications and Information Administration (NTIA). The Task Group also met with, or interviewed, DoD stakeholders and policy makers, including leaders from: the Office of the Assistant Secretary of Defense for Networks and Information Integration (ASD(NII)), the Defense Spectrum Organization, and Army, Navy and Air Force Spectrum Offices. Finally, the Task Group met with interagency spectrum leaders, including National Aeronautics and Space Administration and communications technology developers.

The Task Group presented their findings and recommendations to the full Board on January 21, 2010. A copy of the briefing containing the final recommendations as approved by the Board may be found in **Appendix B**.

Conclusion

While the Business Board does not generally advocate use of extreme language or use of words like “crisis” – the Task Group agreed that they see an impending crisis based on current trends which could result in:

- a. Increasing inability of the Department’s armed forces to “train like they fight”;
- b. Critical spectrum-dependent systems, including vital radar systems being degraded or inoperable; and
- c. Weapons available to Combatant Commanders being limited during engagements due to lack of spectrum access, interference, and local country conflicts in many parts of the world.

There are no easy solutions to address these spectrum challenges. Getting ahead of this deteriorating situation will require a change in DoD strategy, but DoD does not always own the solution space. Therefore, DoD may have to take a stronger role in the interagency arena to effect changes

that will result in a favorable strategic environment with respect to spectrum, which is becoming a scarce resource.

Below are the findings and recommendations of the Task Group:

FINDINGS

1. Spectrum access is critical to DoD's global mission. One of the biggest challenges today is global interference with DoD radar systems. There are also other problems occurring today such as blue force deconfliction and red force jamming.
2. While radio spectrum is allocated to Federal users (including DoD), global demand is increasing at an alarming rate due to communications/mobile demand. Federal initiatives and increasing commercial pressure will further increase demand on spectrum, independent of any legislation— the commercial sector is today seeking an additional 800 megahertz below 3 gigahertz. Meanwhile, DoD access is contingent on international regulations, world radio conference decisions and host-nation agreements.
3. Spectrum has not always been viewed as a tangible asset. Historically, DoD has had little incentive to be efficient with it, however, this has been improved recently as more attention has been placed on spectrum availability. Since demand for commercial wireless applications has dramatically increased, DoD has had to implement strategies to become more efficient as its own requirements continue to increase while its access to spectrum has been diminishing. The licensed commercial sector is already beginning to place monetary value on spectrum access, especially since the last few spectrum auctions. Similar market approaches are not appropriate mechanisms for the DoD, but some consideration should be given towards developing the proper approach to provide incentives within DoD to more properly value spectrum.
4. The Federal Strategic Spectrum Plan is seen as a compilation of current and future requirements of executive branch agencies, not an actual national or strategic plan where federal requirements

have been prioritized. A Federal strategy/plan is badly needed for all executive branch agencies – it does not exist today.

5. DoD needs improved data on current spectrum use and future demand. The Task Group was unable to obtain *specific* data on DoD's projected demand. However, DoD was able to provide qualified statements on expected growth in demand, based mainly on projected communications bandwidth needs.
6. Numerous studies over the last ten years with similar recommendations and recurring themes and multiple strategy documents have recommended improvements in DoD's approach to addressing long-term spectrum challenges, but they have not led to strategic options sufficient to solve the problem. DoD has taken some steps to implement policies and strategies (e.g., DoDI 4650.01; DoDI 5000.02; establishment of the Defense Spectrum Organization; support to Unmanned Aerial System deployments; developing new policies on spectrum efficiency, management, and data) that address longer-term challenges, but given the pace of changing spectrum requirements, more needs to be done.
7. DoD is perceived as having superior technology and a superior ability to develop technology innovations, while the commercial sector is perceived as more practical in use of flexible technologies that decrease spectrum required for some applications. In reality, the difference between commercial and military applications drives significant differences between their spectrum usages. While spectrum efficiency is very important to DoD, mission effectiveness is the major driver of DoD's spectrum use.
8. There is a perception that DoD does not fully use its allocated spectrum which generates speculation from the Legislative Branch, some Federal agencies, and commercial sectors.
9. Short-term fixes to DoD databases are underway, and recent increases in funding are going to facilitate improving these databases. Medium range options for improvement are under

way, but the long-term solution may require a strategic shift which is not defined or funded.

10. Existing DoD structures, decision processes and assignments need to evolve to handle growing spectrum challenges. Otherwise DoD will not be able to keep pace with demand, which could affect timelines for DoD to respond to crisis and combat measures.
 - a. While ASD(NII) has spectrum oversight and policy development role, spectrum management is distributed via the Military Services. Additional staffing and resources may be needed to oversee the development of new technologies that will be required to provide the spectrum needed for future combat missions.
 - b. Implementation of DoD spectrum planning/policy has most often been near-term and reactionary; department-wide support for and emphasis on spectrum improvements has historically abated once the perceived near term “threat” abates. DoD should continue to improve its capacity to enforce spectrum policies across the Department.
 - c. DISA’s long-term planning function is often impacted by day-to-day operations and real-time crises.
 - d. Increased DoD leadership focus on Spectrum is needed now.
11. GAO studies have been critical of DoD and government spectrum management and use. They include concerns over the structure and management of spectrum use.¹

In the Task Group’s opinion, DoD must balance the need to have ready access to spectrum for contingency operations or crises and the economic benefit of other uses. DoD needs to develop more dynamic mechanisms for spectrum use.

¹For example, GAO-04-666, “Spectrum Management: Better Knowledge Needed to Take Advantage of Technologies that May Improve Spectrum Efficiency,” May 2004, Highlights, paragraph 2.

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“DoD would be naïve at their own risk to continue to work independent of other parties in future spectrum use.”
-Former FCC official

RECOMMENDATIONS

Based on the observations above, the DBB approved the following four recommendations to the Secretary of Defense.

1. Continue to develop and implement management efficiencies.
 - a. Updating existing spectrum data use, improving the accuracy and implementing data standards.
 - b. Empower a stronger central ASD(NII) office that is responsible for spectrum planning and implementation of needed strategy changes using the day-to-day support of the DISA spectrum organization and fund the department to achieve the changes required.
 - c. Continue to develop more effective ways to assign static spectrum assignments and fully support modernized spectrum assignment tools such as Spectrum XXI On-Line² in the short term and GEMSIS³ in the mid-term.
2. Pursue flexible, robust and adaptable RF systems. Move toward dynamic capability using technologies and policy-based controls.
 - a. Continue to evaluate and develop Dynamic Spectrum Access (DSA)⁴ capabilities.

² Spectrum XXI On-Line is an emerging web-based spectrum management/frequency assignment tool that will replace the legacy client-server based system; implementing a new spectrum data exchange standard and providing higher fidelity engineering and improved visualization. Source: Defense Spectrum Organization briefing to the Defense Business Board Task Group, 26 August 2009.

³ Global Electromagnetic Spectrum Information System (GEMSIS) is the first joint program of record for spectrum data management and assignment, designed to move from a pre-planned and static frequency assignment into a more dynamic, responsive, and agile capability. The capability would provide a joint architecture and deconflict spectrum use and would also include automated tools that support operational mission planning and rehearsal, simulation-based acquisitions, and national-level spectrum management. Source: GEMSIS Initial Capability Document (ICD) (dated 26 Sep 05) as approved by Joint Requirements Oversight Council (JROC) 23 Jan 06.

⁴ The Institute of Electrical and Electronic Engineers (IEEE) P1900.1 standard defines DSA as the real-time adjustment of spectrum utilization in response to changing circumstances and objectives. Source: Briefing to the IEEE 1 Aug 08, slide 4, http://grouper.ieee.org/groups/scc41/files/IEICE_SCC41_01Aug08.pdf accessed Jan 2010. Examples of DSA capabilities could include software defined radios, cognitive radios, or adaptive antennae.

- b. Proactively make systems more robust, to resist interference and change frequencies.
 - c. Bring adaptable technologies to an operational capability. Pursue alternative technologies (e.g., plug into fiber, develop alternate means to RF).
 - d. Consider use of higher frequencies; those under less commercial pressure/demand.
 - e. Consider additional spectrum sharing opportunities.
3. Pursuing recommendations one and two above will not likely result in meeting expected RF spectrum demand, and thus the Task Group also recommends DoD pursue strategic changes that decrease DoD reliance on RF spectrum.
- a. Immediately investigate technological development to find ways to reduce DoD reliance on classical RF spectrum.
 - b. Challenge the status quo and look for new green field technologies. These technologies would change the way DoD deals with existing constraints and move beyond point-to-point physics.
 - c. Implement a more urgent top-down, proactive strategy for improved use and management of spectrum, including increased management oversight by ASD(NII), and establish the appropriate authorities that are required for DoD to obtain unity of effort and fully implement needed changes throughout DoD.
4. Finally, the Task Group suggests a future study focus on “game-changing” technologies that could achieve this long-term objective, and suggests that the DSB lead such a study.


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Ultimately, strategic changes are needed to reduce DoD's reliance on RF spectrum. While a long-term solution is needed, DoD needs to be proactive today to maintain their ability for modern warfare in the future.

Respectfully Submitted,



Joe Wright
Task Group Co-Chairman



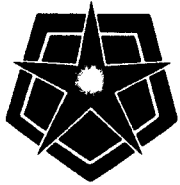
John P. Stenbit
John Stenbit, DSB
Task Group Co-Chairman

Defense Business Board

APPENDIX A
TERMS OF REFERENCE

Defense Business Board

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DEFENSE BUSINESS BOARD
1155 DEFENSE PENTAGON
WASHINGTON, DC 20301-1155

June 30, 2009

MEMORANDUM FOR JOE WRIGHT, (CO-CHAIR),
JOHN STENBIT, DEFENSE SCIENCE BOARD (CO-CHAIR)
ATUL VASHITHA



SUBJECT: Terms of Reference – DBB Task Group on “A Review of Spectrum Management”

With advanced communications technologies, particularly wireless, the Department of Defense faces ever increasing challenges to retain its allocation of radio spectrum. The Nation’s economic decline also creates new pressures to auction radio spectrum to generate revenues and meet commercial sector demands.

Using your extensive experience in the area of global radio communications, I would like you to form a Task Group with support from the Defense Science Board, to review the Department’s policies and use of radio spectrum and offer the Secretary of Defense recommendations on how to better manage and use radio spectrum. Please assess the Department’s current practices and identify opportunities to better support the Department’s needs.

Joe and John will serve as co-chairs with support from Atul. Stephen Price is also available to assist. Please plan to present your findings and draft recommendations to the full Board at the October 2009 quarterly meeting. The Assistant Secretary of Defense for Networks and Information Integration and the Vice Chairman of the Joint Chiefs of Staff are valuable resources for identifying policy and warfighter requirements. Col Kathleen Sakura from the DBB staff will serve as the Secretariat Representative.

As a subcommittee of the Board, and pursuant to the Federal Advisory Committee Act of 1972, the Government in the Sunshine Act of 1976, and other appropriate federal regulations, this Task Group shall not work independently of the Board’s charter, and shall report its recommendations and advice to the Board for full public deliberation and discussion. The Task Group does not have the authority to make decisions on behalf of the chartered Board, nor can they report directly to the Agency or any federal officer or employee who is not also a Board member. This Task Group will avoid discussing “particular matters” within the meaning of Section 208 of Title 18, U.S. Code, and will not cause any member to be placed in the position of acting as a procurement official.


Michael J. Bayer
Chairman


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APPENDIX B

**FINDINGS AND RECOMMENDATIONS PRESENTED
TO THE FULL BOARD ON JANURARY 21, 2010**

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A Review of Spectrum Management

January 21, 2010

Task Group Overview

Terms of Reference

With support from the Defense Science Board, review the Department's policies on use of radio spectrum and offer the Secretary of Defense recommendations on how to better manage and use radio spectrum.

Deliverables

Draft report of the Task Group findings will be presented to the Defense Business Board at the January, 2010 meeting - further review and reports will be recommended and decided on at that meeting.

Task Group

Mr. Joe Wright (Co-Chair)

Mr. John Stenbit (Co-Chair) - Defense Science Board

Mr. Atul Vashistha

Mr. Steven Price, Consultant

Military Assistant

Colonel Kathleen Sakura, USAF

Process

- Reviewed former studies, including Defense Science Board, Air Force Scientific Advisory Board, Government Accountability Office (GAO) Reports, and the Federal Spectrum Plan for demand/supply trends and prior recommendations on DoD use of spectrum.
- Interviewed senior leaders, including:
 - Current and former Federal Communications Commissioners
 - Department of Commerce, National Telecommunications and Information Administration Leadership
 - DoD stakeholders and policymakers
 - Defense Spectrum Users
 - Defense Spectrum Managers
 - Office of Management and Budget
 - Former US Ambassadors to international telecommunications conferences
 - Technology Developers

Conclusion

The Task Group sees an impending crisis, based on current trends, that could result in: (a) the inability of our armed forces in CONUS to "train like we fight" and to test new systems; (b) render critical spectrum-dependent systems (including vital radar systems) degraded or inoperable; and (c) limit the weapons available to Combatant Commanders during engagements due to lack of spectrum access, interference, and local country conflicts in many parts of the world.

There are NO SILVER BULLETS, NO PANACEA to fix spectrum issues. Will require a change in DoD Strategy

Findings (1)

1. Radio spectrum allocated; global demand increasing at alarming rate due to communications / mobile demand; commercial sector seeking another 800MHz below 3GHz; Administration may make more spectrum available for wireless Internet services
2. Spectrum access critical to DoD's global mission
 - Big challenge: global interference with DoD radar systems;
 - Potential DoD spectrum conflicts include: decreased radar and Ballistic Missile Defense effectiveness, radio interference / inoperability, UAV feeds slowed down/frozen, Precision Guided Munitions targeting errors, etc;
 - Expanding spectrum use by DoD causes problems at home and in theater (blue force deconfliction and red force jamming);
 - DoD access contingent on international regulations, World Radio Conference decisions and host-nation agreements - sources feel DoD does good job negotiating spectrum access overseas so far;
 - Complex Problem Set – DoD doesn't own solution space.



Findings (2)

3. Federal initiatives, such as the National Broadband Plan and increasing commercial pressure will increase demand on Spectrum, independent of any legislation.
4. The Federal Spectrum Plan (agency requirements) - developed in 2008 under review; there is no national or strategic plan and no specified timeframe for developing such a plan.
5. DoD needs improved data on current spectrum use and future demand in order to plan for high-priority spectrum demand, supply, and technologies
6. Numerous studies over last ten years with similar recommendations and recurring themes, and multiple “strategy” documents have not resulted in a coordinated department-wide approach to addressing long term spectrum challenges (i.e., Air Force Scientific Advisory Board 2008 Study, Defense Science Board 2000 Study)
7. Spectrum not always viewed as a tangible asset in the past. Little incentive to be efficient with it, preserve it, etc.

Findings (3)

8. DoD has better technology but commercial sector may be more practical in use of flexible technologies—(i.e., moving toward a 4G / “LTE” network; wireless plug into IP) are decreasing spectrum required for some applications.
9. Perception that DoD does not fully use its allocated spectrum generates speculation from legislative, government agency, and commercial sectors
10. Short-term fixes underway (recently fully resourced) and medium-range options for improvements under consideration; but long-term solutions may require a strategic shift which is not defined or funded
11. GAO has conducted several studies and found that investments (in Spectrum technology) have tended to occur when agencies needed to make greater use of available spectrum to meet mission requirement – not by an underlying, systemic consideration of spectrum efficiency.
 - GAO also concluded that “the current structure and management of spectrum use in the United States does not encourage the development and use of some spectrum efficient technologies”

Findings (4)

12. Existing DoD structures, decision processes and assignments need to evolve to handle growing Spectrum challenges

- While ASD/NII has spectrum policy and oversight role, spectrum management distributed via Services; ASD/NII has authority for department-wide strategy/policy, and should continue to improve its enforcement of policies;
- Implementation of DoD Spectrum planning / policy has been near-term and reactionary; emphasis on Spectrum abates once near term “threat” addressed;
- DISA supports day-to-day spectrum management (laborious legacy systems and databases), but also develops improved data handling capabilities; long-term planning often impacted by real-time crises;
- Ad-hoc groups (e.g. Radar Spectrum Working Group; Dynamic Spectrum Access Working Group) trying to plan for future technologies
- DoD and Federal leadership needs to exist to address issue

**Department will not be able to keep pace with demand;
timelines for DoD to respond will compress**



Recommendations

Address Spectrum Management Problem Near-to-Far Term: Three “Categories”

1. Develop and Implement Management Efficiencies

- DISA to update spectrum data use—standardize and improve data accuracy in FY2011-13; may not be soon enough for some systems (e.g., priority radars)
- Improve governance of spectrum
 - Empower central DoD office responsible for planning and implementation
 - Complete DoD-wide data use policy by ASD/NII by mid-2010
 - Develop coordinated effort to assess current / future spectrum needs / technologies
- Better allocate existing DoD Spectrum through continued tool development:
 - Develop more effective way to assign static spectrum assignments
 - Standardized databases and streamlined operational assignment tools (e.g., Spectrum XXI on-line, GEMSIS) – developed by DISA, need DoD support
 - Former FCC Official: “80% of the spectrum is not used 80% of the time”
- Strengthen DoD’s interagency efforts
 - Continue to work with other USG agencies to obtain regulatory flexibility
 - Support NTIA lead role for Federal Government prioritization of Spectrum

Expected marginal improvement in available spectrum. DoD and Services working to increase spectrum efficiency, but this will not meet expected demand. New policy and technology management changes needed today.



Recommendations

2. **Pursue Flexible, Robust, and Adaptable RF Systems:** Move toward dynamic capability using technologies and policy-based controls.
- Develop dynamic spectrum access (DSA) capabilities to enable existing and future devices to utilize multiple spectrums, waveforms, power, etc (e.g., software defined radios, cognitive radios, real-time sensing, adaptive antennae).
 - Proactively make systems more robust: increase ability to resist interference, and change frequencies
 - DISA continue to work closely with ASD/NII, DARPA, and the Services to bring adaptable technologies to an operational capability; pursue other technologies (e.g., plug into fiber, alternate means to RF)
 - DoD acquisition programs do not always address cross-program issues (challenge not unique to Spectrum); legacy conversion problems
 - Use of higher frequencies, those under less commercial pressure/demand, is reasonable option to expand spectrum to DoD, albeit at higher cost
 - Use of additional spectrum sharing with commercial sector should be considered to a greater degree

Expected improvement only a factor of 2 to 3 times— still not sufficient to satisfy expected demand

Recommendations

Two categories above will likely yield only incremental improvements, while demand is growing exponentially – **NEW STRATEGY NEEDED; CHALLENGE THE STATUS QUO**

3. To meet future requirements, Pursue Strategic Changes

- The ONLY real and lasting long-term solution to satisfy DoD's future requirements is to immediately investigate technological development and R&D to find ways to reduce DoD reliance on RF spectrum – our future combat forces will require such "game changing" technologies.
 - Technologies that change the Department's ability to deal with constraints and move beyond "point-to-point" physics (i.e., fiber optics, optical lasers, space-based options, and other "green fields.")
- DoD should develop a fully supported and executable strategy for proactive approach to near and long-term improved use and management of spectrum – should be top-down, and consider appropriate management oversight and authority changes required to obtain unity of effort and fully implement changes throughout the department

Recommendations

4. Follow-on study:

- DoD has studied strategic changes in the past, i.e, shifting from circuit-based, RF technologies to IP-based.
- The DSB, with DBB support, could conduct an updated review to evaluate technologies--and associated “strategic changes”--and provide DoD with recommendations for future Spectrum use.

“DoD should be the leader in developing technical solutions to spectrum availability – they have the most brilliant technicians in the industry”

“DoD would be naive at their own risk to continue to work independent of other parties in future spectrum use”

- Former FCC Official

Outbriefs

- Deputy Secretary of Defense
- Under Secretary of Defense for Acquisition Technology and Logistics, USD/AT&L
- Vice Chairman, Joint Chiefs of Staff
- Assistant Secretary of Defense for Networks and Information Integration, ASD/NII
- Director, Defense Information Systems Agency

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Questions?

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Backup Slides

Terms of Reference



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June 30, 2009

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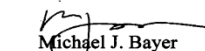
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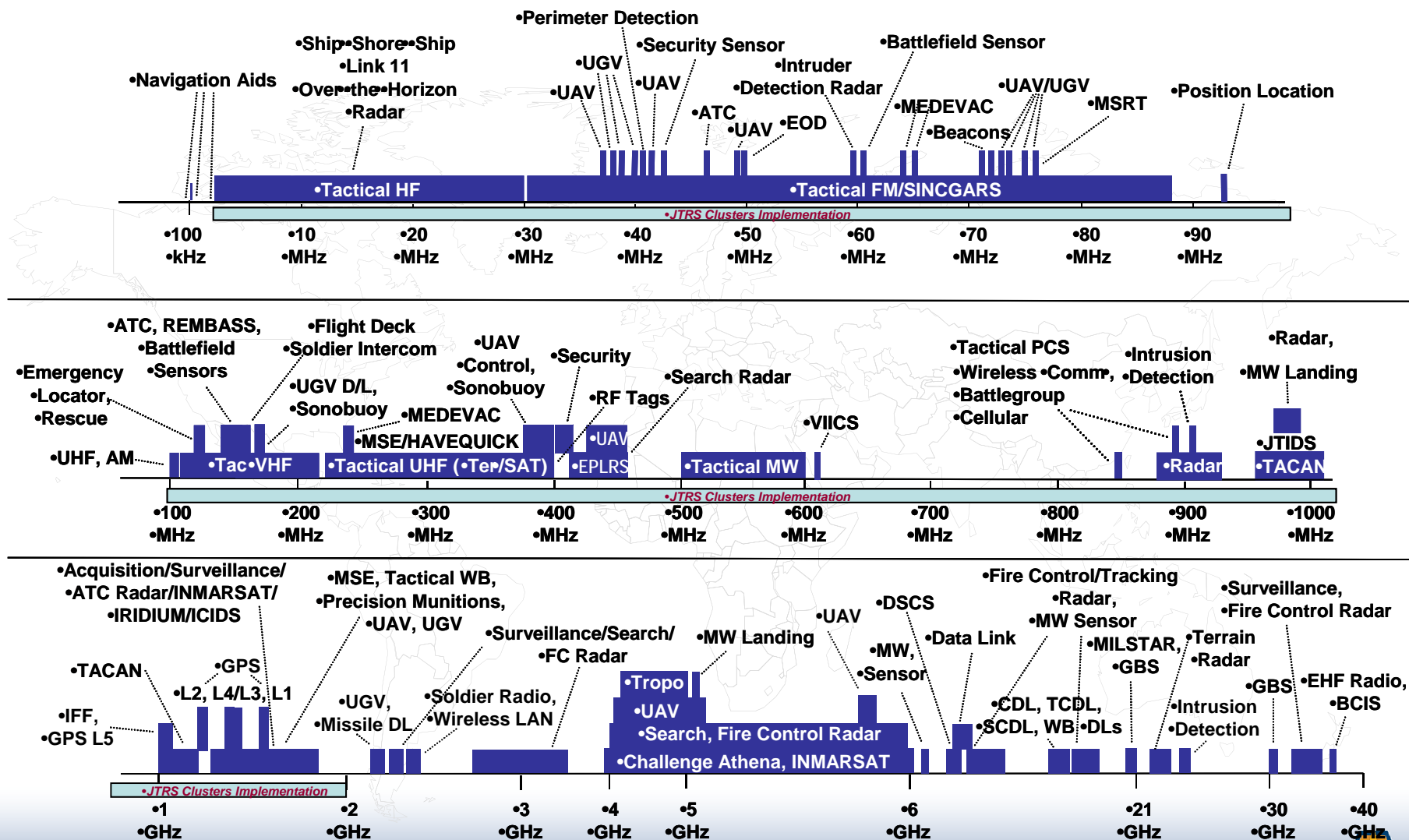
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Chairman

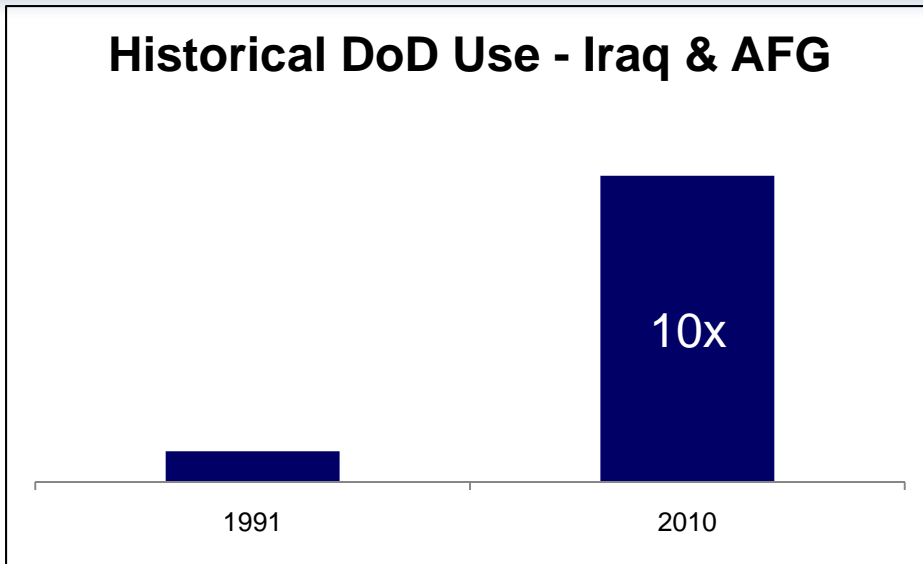
Warfighter Spectrum Use Below 40 GHz - Snapshot

Source: Defense Spectrum Organization



Bandwidth Demand

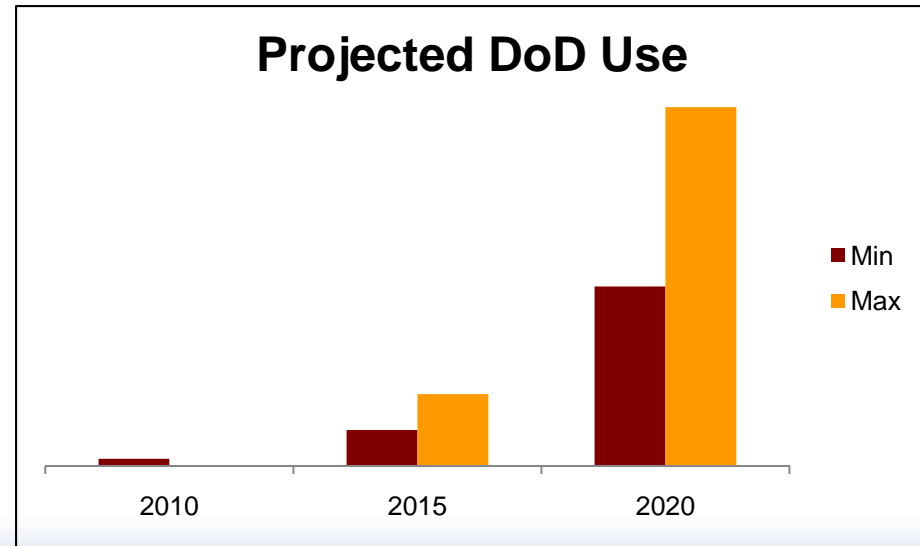
Historical DoD Use - Iraq & AFG



Iraq and AFG wars using 10 times more bandwidth (spectrum) than the Gulf War (Dr Jost, 14 Oct 09)

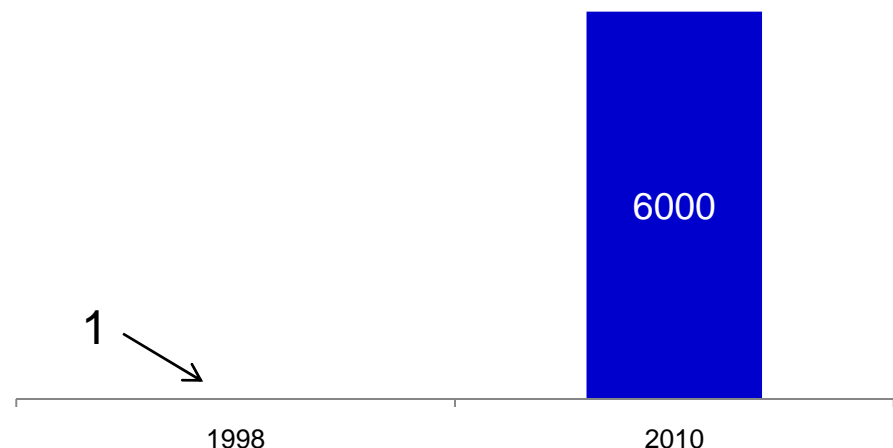
U.S. military projects a demand increase 5 to 10-fold every 5 years. (Dr Jost, 14 Oct 09)

Projected DoD Use



Demand Drivers

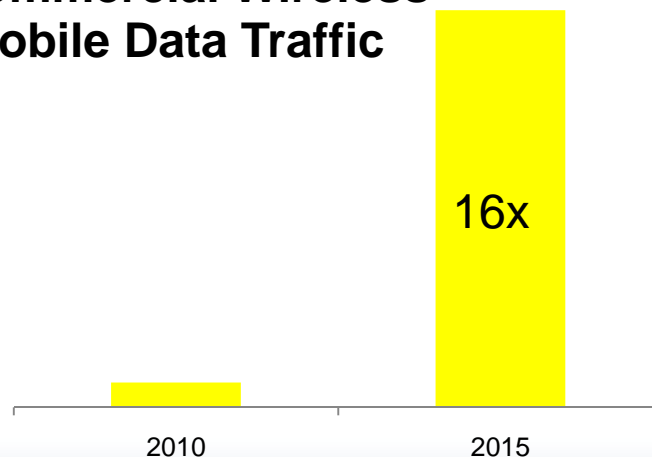
Unmanned Aerial Vehicles



UAV Operations are one of many things driving DoD Communications Bandwidth and Spectrum Demand. In 1998, One UAV in operation. More than 6,000 today (Dr Jost, 14 Oct 09)

Mobile data traffic expected to increase 16-fold in 5 years (Susan Crawford, 16 Oct 09)

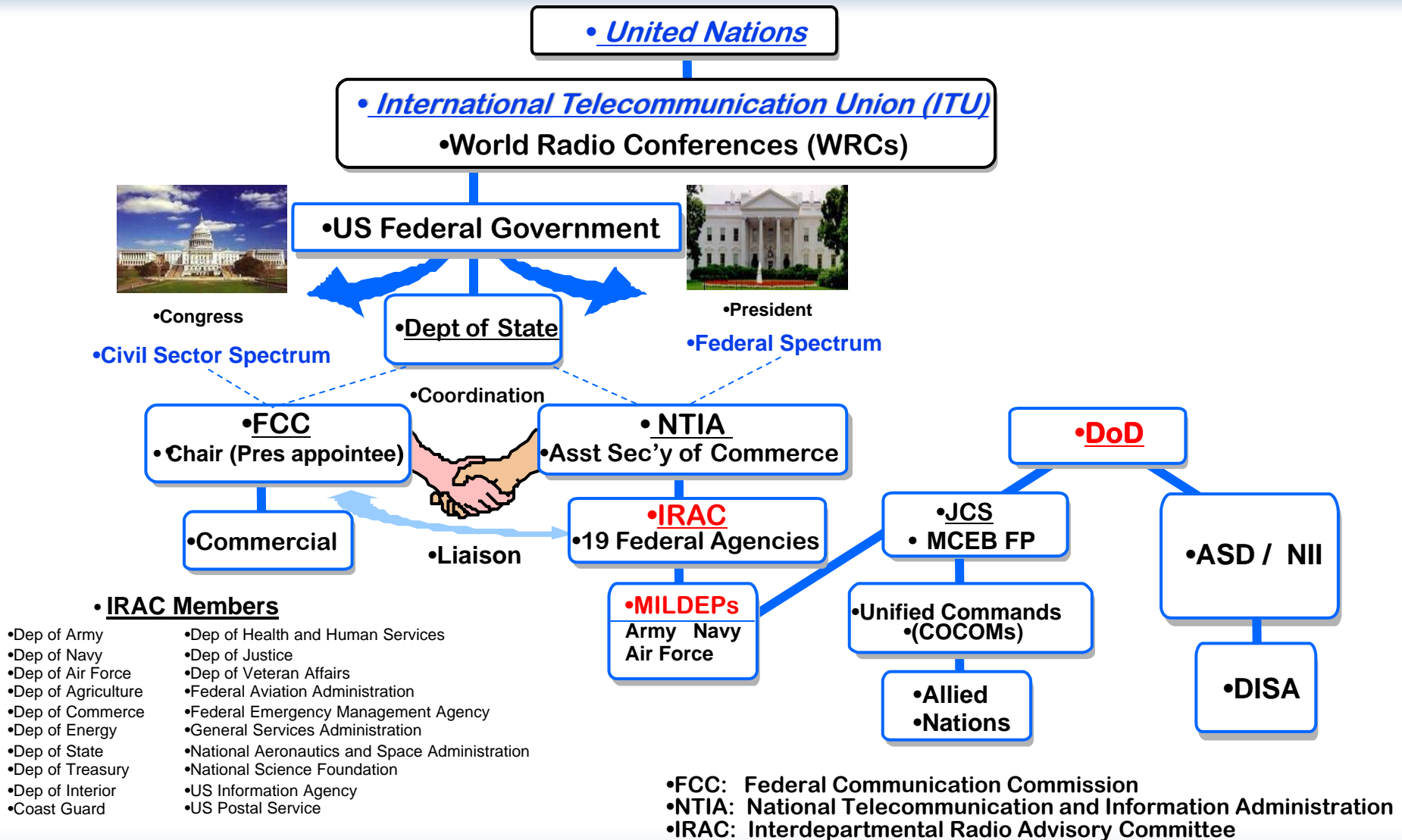
Commercial Wireless Mobile Data Traffic



Potential Operational Impacts

- Mobile Communications
 - *Incomplete Common Operating Picture (COP), Missed Commands, Disrupted Missions*
- Navigation
 - *Unknown Location, Wrong Target, Collateral Damage*
- Sensors
 - *Undetected Enemy, Unidentified Friends, Fratricide*
- Shooters
 - *Missed Targets, Collateral Damage*
- Logistics
 - *Lost Supplies, Delayed Operations*
- Information Operations
 - *Electronic Fratricide*

Spectrum Management Coordinating Organizations



Persons Interviewed

- 1. Dr. Ron Jost – Deputy Assistant Secretary of Defense for C3, Space and Spectrum**
- 2. Ms. Paige Atkins – Director, Defense Spectrum Organization**
- 3. Lt Gen (Ret) Charlie Croom – Former Director, Defense Information Systems Agency**
- 4. Mr. Danny Price – Director of Communications and Spectrum Policy, ASD/NII**
- 5. Mr. Stu Timmerman – Director for Army Spectrum**
- 6. Mr. Dave Weddel – United States Navy, Deputy to the Deputy Chief of Naval Operations, Communication Networks**
- 7. Col Brian Jordan – United States Air Force; Commander, Air Force Frequency Management Agency**
- 8. Mr. Michael Powell - Former Chairman, Federal Communications Commission (FCC)**
- 9. Ms. Meredith Baker, Commissioner, Federal Communications Commission and former acting head of NTIA**

Persons Interviewed

- 10. Assistant Secretary Larry Strickling - Asst Secretary for Communications and Information, Department of Commerce. Also, Chairman of the National Telecommunications and Information Association (NTIA)**
- 11. Mr. Badri Younes, Dep Associate Administrator for Space Communications & Navigation (SCaN) Space Ops Msn Directorate National Aeronautics and Space Administration (NASA)**
- 12. Mr. Vic Sparrow, Spectrum Director, NASA**
- 13. Ambassador Richard Russell, former AMB to the World Radio Conference**
- 14. Ambassador David Gross, former US AMB to major international telecommunications conferences.**
- 15. Ms. Karen Evans, Office of Management and Budget**
- 16. Dr. Scott Stadler, Lincoln Labs**
- 17. Dr. Albert “Buzz” Merrill – the Aerospace Corporation**



Backup: Legislative language requiring certification when DoD is moved out of spectrum

- Ref. 22, § 2.3.13: Special Conditions for Department of Defense Use of the Spectrum
- Title X, Subpart G, Section 1062 of the National Defense Authorization Act for Fiscal Year 2000, the Department of Defense shall not surrender use of any band of frequencies in which the Department of Defense is a primary user for non-federal use, unless it meets several conditions:
 - NTIA and FCC make alternate spectrum available
 - SECDEF/CJCS certify that replacement spectrum will restore essential military capability